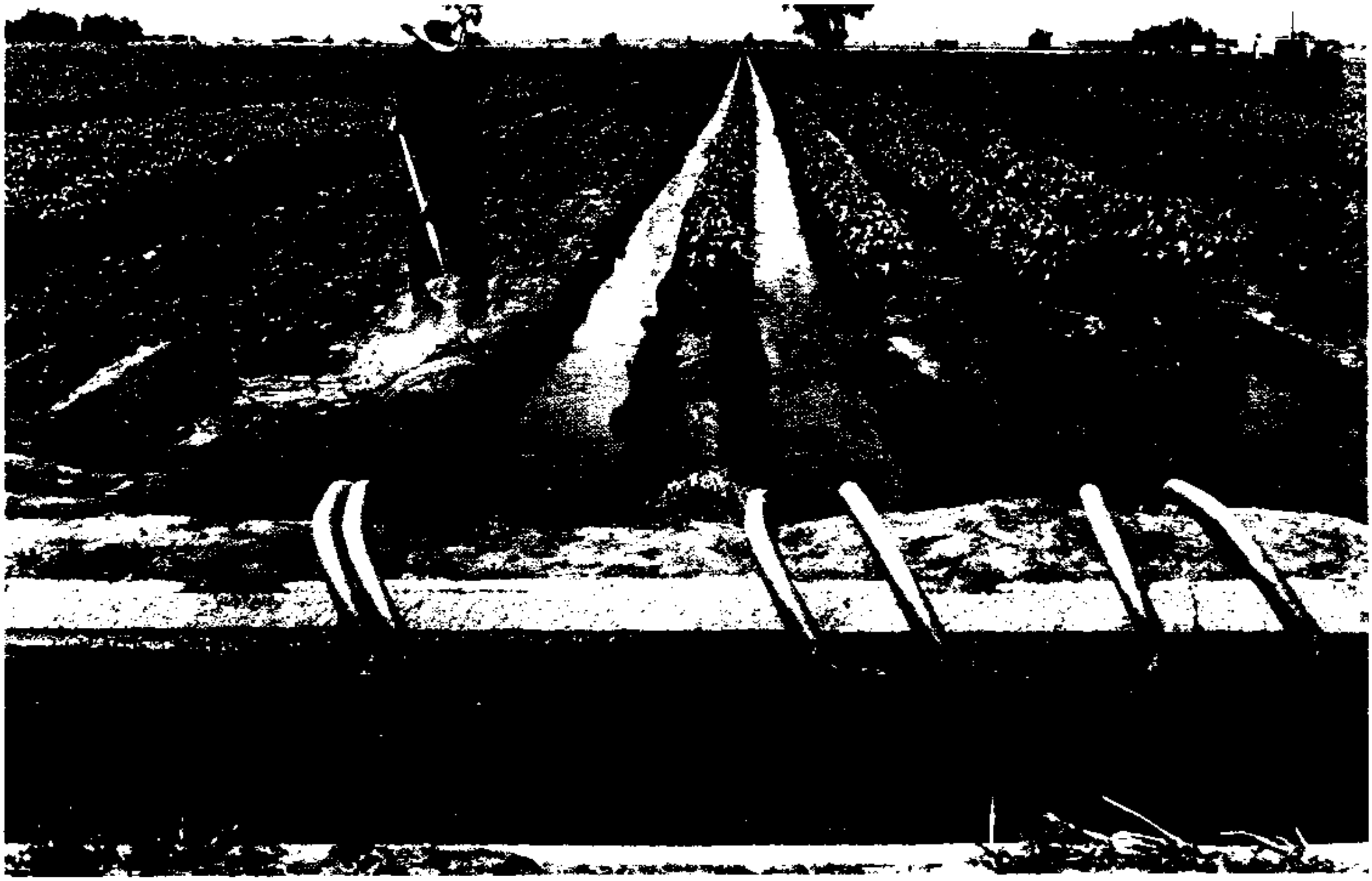

# Irrigation trash screens pay!

By W. D. Kemper,
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*Inexpensive screens that remove trash from irrigation water save soil, water, and labor*

FARMERS control the application of water on irrigated farms in arid regions. Consequently, the erosion of up to 18 tons of soil per acre per year (*1*) in irrigated row crops appears at first glance to be a self-inflicted, unnecessary loss.

Often compounding this loss is trash in the irrigation water, which increases runoff and erosion problems. For most irrigation farmers, therefore, screens to remove trash from incoming water are a sound investment, not only to reduce soil erosion but to improve the cost-effectiveness of irrigation.

## Why furrow erosion?

Detachment of soil in an irrigation furrow occurs when the force of flowing water exceeds the cohesion between soil particles. That cohesion depends on such factors as texture, recency and type of cultivation or compaction, bonding materials in the soil, type of ions adsorbed, water content prior to wetting, and rate of wetting (*6*).

Clean-tilled silt loam soils erode at a rate roughly proportional to the irrigation flow rate squared. Flow rates exceeding those required to get water to the end of rows are thus a major cause of furrow erosion.

## The matter of trash

Improved surface irrigation systems generally involve orifices or siphon tubes of specific sizes to help a farmer keep furrow supply rates uniform. In several systems studied, the coefficient of variation in flow from siphons averaged 15 percent while that from gated pipe averaged 25 percent when the gates and siphons were cleaned before the measurements (unpublished data). Where there is appreciable trash in the water, siphons and pipe gates can be partially or completely blocked, which increases significantly the variability in furrow supply.

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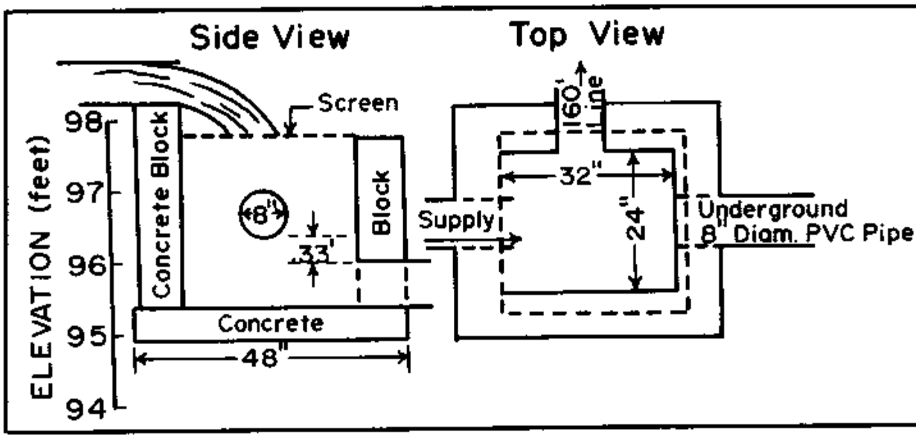
Many irrigators who have trashy water check their outlets and restart siphon tubes or clean out gates one or more times during each irrigation set to improve application uniformity. In the Twin Falls, Idaho, canal system, for instance, where a large portion of the tail water from farmers fields is fed back into the laterals, six irrigators contacted at random indicated they spent from 10 to 60 percent of their irrigation time resetting tubes and/or cleaning gates.

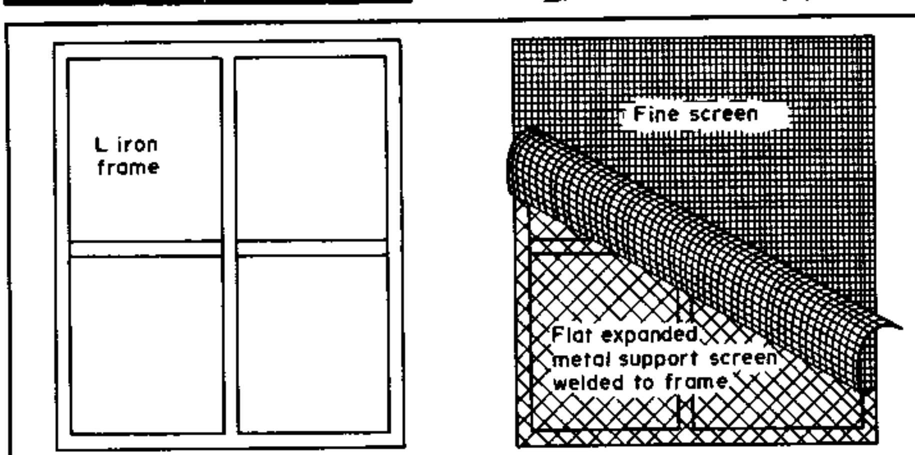
To help a furrow "catch up" with the others after the orifice supplying it has been plugged with trash, some irrigators put extra water into that furrow by opening the gate wider or starting an extra siphon tube. That extra flow rate adds to the erosion problem.

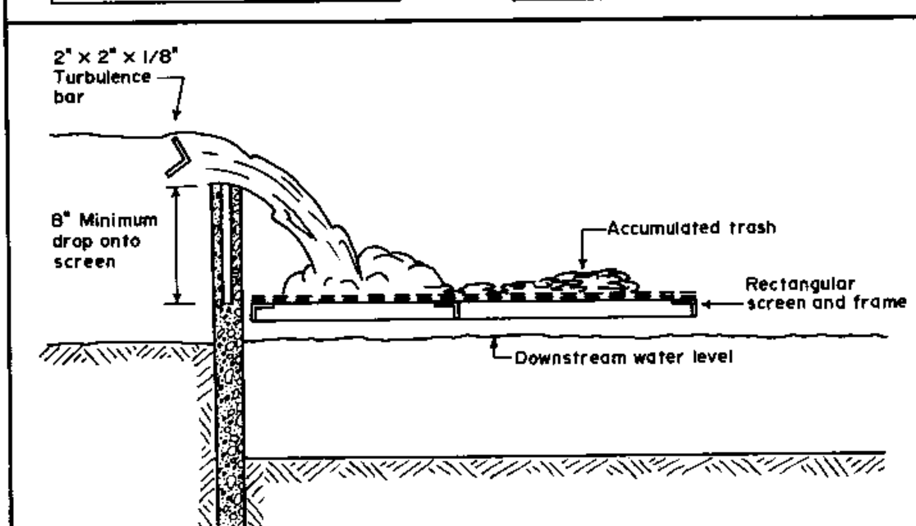
Some irrigators use larger diameter siphons when they have to deal with trashy water because the larger tubes pass more of the trash without plugging. To reduce flow they generally raise the outflow ends of the tubes, which reduces the head. But the tendency still is to supply more water less evenly with the larger siphons.

Effects of trash-blocked outlets on soil erosion depend upon the type of irrigation system. In a gated-pipe system, where the end is blocked and other gates are closed, all water must exit from a limited number of open gates. If trash blocks some of the open gates, water backs up in the pipe. This increases the pressure, forcing higher flows from the remaining open gates. If half the open gates are blocked by trash, flow from the remaining open gates doubles and pressure in the pipe increases by a factor of four. The result is enlarged pits where jets from the gates hit the soil. Erosion in the furrows served also is about four times the erosion that would occur if no gates were plugged.

Recognizing this erosion, some farmers raise the ends of their pipe lines a foot or two above the level of the outlets and leave the ends open. This limits the pressure that can develop in the pipes and avoids the excessive erosion that occurs if some furrows in the set become plugged. But serious erosion can occur in the channel, carrying water away from the open end of such a pipeline unless that channel is well designed. In either case, water is wasted, rows that depend on the blocked outlets are not adequately irrigated, and production declines.




**Top: Schematic and photo of a horizontal screen and structure for removing trash from irrigation water. Lower middle: Construction of a horizontal trash screen. Bottom: A trash screen below a check or drop structure (side view).**

Sloping irrigation supply ditches, where siphon tubes are used, commonly have successive check boards. These boards raise from irrigation water.the water level in the sections above each check to the desired height and allow excess water to flow over them. The number of furrows to be irrigated is practically determined by initiating flow from the ditch into furrows with siphon tubes. This process starts at the highest section and continues until water stops going over the check board that is on the downstream side of the bottom section. When trash clogs a tube, the water that tube was taking goes downstream and flows over the check on the bottom section. On supply ditches with little slope the channel freeboard is sometimes insufficient to direct a large portion of the flow over the checks. Clogging of siphon tubes on such ditches can lead to over-topping of ditch banks and severe erosion caused by the concentrated flow.

Siphon-tube irrigation is particularly vulnerable to trash because the trash is often held against the opening by the suction in the tube. Once air enters from the outlet end, the suction is released and the trash drifts down to the next tube, which often picks it up again.

On one head ditch observed during the first irrigation of the year, which is the heavy trash season, an irrigator set 107 siphon tubes (3/4 inch in diameter) in 18 minutes. When he walked back down the ditch, 16 tubes had already stopped running. He set them again. By the following morning only 47 of the tubes were still running. About 60 percent of the water was cascading over the bottom check and down the ditch to the drain.

On the same field one supply ditch ran out along a ridge and stopped midway in the field. Tail water from this "stub" ditch was directed to four furrows. Following a siphon irrigation season, the furrows that took the tail water at the end of this ditch were eroded to the plow pan and the channels were about one foot wide. All of this occurred in spite of the fact that the irrigator planned his schedule so that he irrigated from that ditch only during daylight hours when he could reset stopped tubes at least once every two hours.

## The cost of trashy water

Losses to a farmer because of trash in his irrigation water are highly site-specific. The following example is from a 33-acre field that drew trashy water from a gate near the bottom of a lateral and had the stub ditch described above.

Soil erosion in furrows carrying away

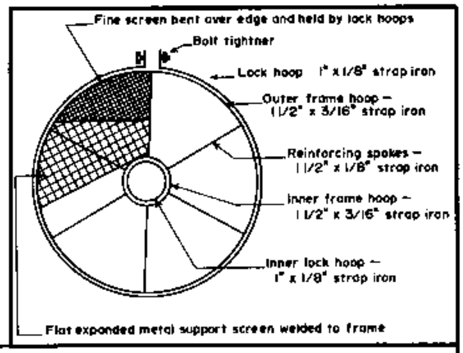
**Turbulent fountain screen with a discharge velocity of four cubic feet per second.**

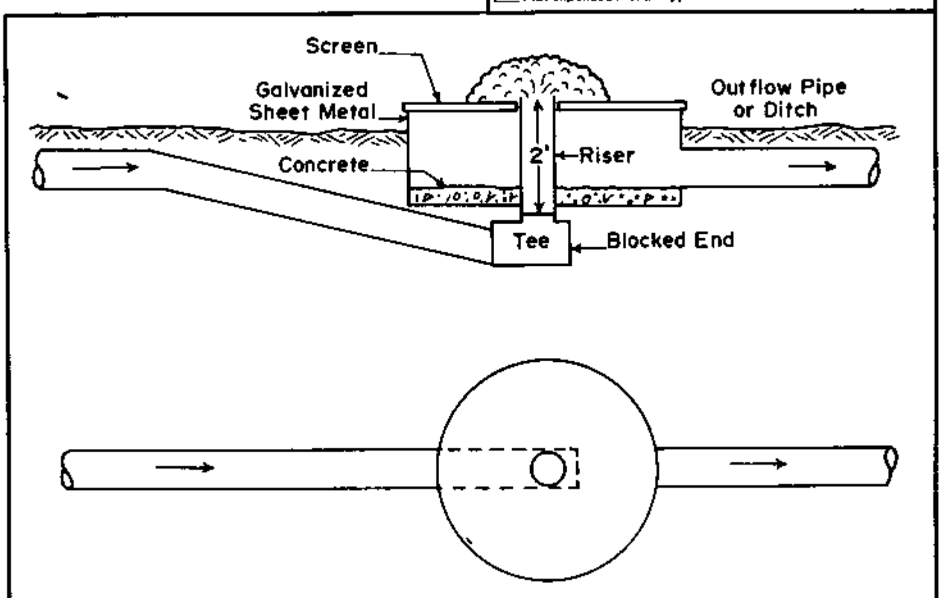
the stub-ditch tail water was about 51 tons during one crop season. Topsoil is estimated to have a value of $2.00 per ton (calculation based on the unpublished data of David Carter). Yellow strips of early-maturing beans indicated furrows that had not received enough water. An experienced farmer in the area who cultivated and harvested this and more than 20 other fields of beans each year estimated a yield loss due to inadequate irrigation of about 10 percent (about 200 pounds/acre x 33 acres x $0.16/pound equals $1,056).

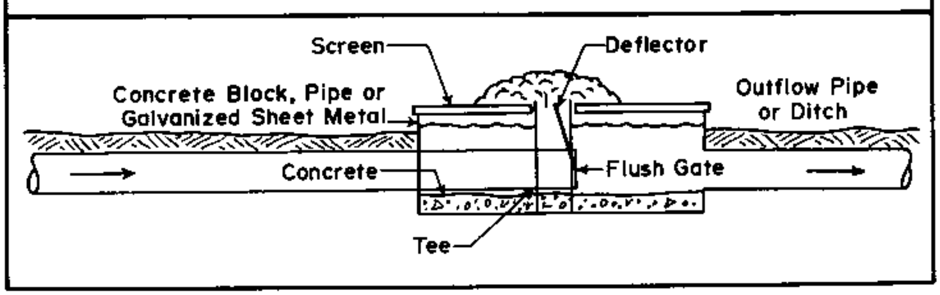
Based on the number of siphon tubes that stopped flowing, it was estimated that 20 percent of the water was lost, which amounted to about 12-acre feet during the season. This water costs about $18 per acre foot, a loss of $216. The cost of this water was less than its value would have been had it been applied to the inadequately irrigated furrows.

The irrigator spent 258 hours irrigating this bean field, about 45 percent of which was spent cleaning and resetting siphon tubes. He was paid $4 an hour, so the time and dollars lost due to trashy water were about 116 hours and $464. Thus, total value during this one season's loss of soil, crop, and labor was at least $780. And the value

**Right: Construction of the screen for a turbulent fountain. Middle: A recommended turbulent fountain screen installation (side view above, top view below). Bottom: An alternate turbulent fountain screen installation (side view).**



may have been more than $1,600, depending on the actual production loss.

The losses due to trashy water in this one field are higher than average. But concerned farmers must assess losses of this type and determine if systems to remove trash from their irrigation water are a good investment.

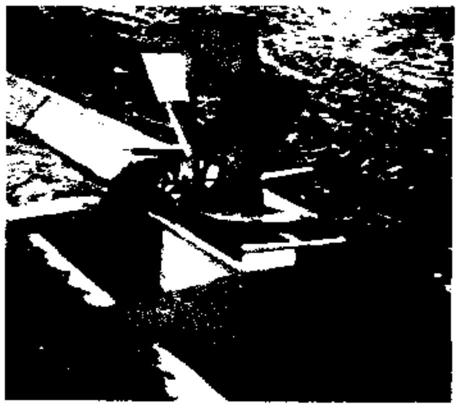
## Use of trash screens

The trash problem in the above situation was largely corrected the following summer by installation of a commercially available flat screen patterned after weed seed screens (2). The system involves dropping the water on a taut, fine-mesh horizontal screen. The action of the water falling on the screen tends to move the trash forward on the screen, leaving a relatively clean area for the water to fall through. This screen was placed on a concrete block structure below a discharge pipe. Total cost of the screen and structure was about $230. During the period when trash load was heaviest, this screen plugged occasionally.

A deflecting board was placed between the pipe and the screen to spread the flow from the pipe over a larger portion of the screen. This also caused more turbulence, which facilitates movement of trash away from the impact area. The constant pressure of laminar flow tends to hold trash on the impact area, eventually clogging the screen. Flows that have a free upper surface, such as flow over a check board, are often relatively laminar and not sufficiently turbulent to keep the impact area clean. Water flows that have solid boundaries on both top and bottom, such as flow from the broad rectangular orifice of a canal turnout, often have sufficient turbulence. Angle irons, placed horizontally at right angles to the flow, with the open side directed upstream, effectively generate turbulence for this purpose (3).

For piped supplies, turbulent fountain screen systems (5) effectively remove trash. An elbow or tee is placed on the end of a pipeline, and water is directed upward through a riser pipe. Some water falls back on the rising water beneath it, causing added turbulence. The resulting flow is unstable and tends to oscillate back and forth across the sections of the horizontal screen.

Discharge velocities of two and one-half feet per second or more create enough turbulence to operate satisfactorily a turbulent fountain trash screen having a 20-mesh-per-inch screen. Screens with 30-mesh-per-inch remove practically all weed seeds, but they require discharge velocities



**A commercially available paddle-wheel screen for concrete ditch systems.**

of at least three feet per second. In some locations they may also require occasional removal of lime collecting on the wires to maintain necessary flow rates. A two-foot-minimum riser height and a tee instead of an elbow achieves the best distribution of flow around the screen. The head required for this screen installation is three inches plus the depth of the screen assembly, about five inches total. Larger heads, when available, do an even better job of removing trash from the impact area on the screen.

Use of shorter risers results in unevenly distributed flow onto the screen. This requires a deflector to help redistribute the flow. In one installation with eight-inch-diameter pipe, a three-inch-wide aluminum deflector vane achieved an acceptable but not completely uniform water distribution.

Turbulent fountain screens must be sized to fit the flow. Adequate turbulence of water on fountain screens depends largely on having adequate discharge velocity. If flow velocities drop below two and one-half feet per second, screen clogging may occur. Clogging can be avoided if reducer rings are fixed in the pipe opening that reduce the area sufficiently to create water velocities greater than two and one-half feet per second in the opening and maintain adequate turbulence. Rings with outside diameters about 0.06 inch smaller than the inside diameter of the pipe, and with inside diameters of the desired sizes, can be made from sheet metal. They can be held in place with sheet metal screws through the walls of the PVC pipe.

**Recommended screen and riser pipe diameters**

| Flow Rate cfs | Flow Rate Miner's (inches) | Screen Diameter (inches) | Riser Pipe Diameter (inches) |
|---|---|---|---|
| 1 | 50 | 42 | 8 |
| 2 | 100 | 48 | 10 |
| 3 | 150 | 60 | 12 |
| 4 | 200 | 72 | 15 |
| 5 | 250 | 84 | 18 |

Commercially available paddle-wheel screens effectively remove most trash from concrete-lined ditch streams. When the screen openings are 0.22 inch in diameter, some short straw and other small trash pass through this screen. This small trash normally passes through sipon tubes, but occasionally clogs sprinklers and small gated-pipe openings. These screens often can operate on less than an inch of head loss.

Other mechanical screens, some driven by water power and some by electric motors (5), are also available. Several of them work effectively, but they are generally expensive to maintain because bearing surfaces wear rapidly due to sediment in the water. Consequently, if five inches or more of head can be made available, systems involving turbulent fall of water onto a screen provide the least expensive and most dependable means for removing trash from water.

## The cost of trash removal

Cost of trash removal installations of this type is generally between $100 and $500. For farmers with appreciable trash in their irrigation water, labor, water, and soil savings, along with increases in production because of improved irrigation, will more than pay for the installation during the first season.

Aluminum screens last a year or two. Stainless steel screens have lasted for more than five years. The main part of the installation should last for 10 years or more.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